

Claims

1. A method for transferring heat using first and second gas adsorbent materials, the second material being relatively thermally isolated from but in continuous gas communication with the first material, the method comprising the steps of:
 - (i) heating the first material so as to desorb a gas adsorbed onto the first material whereby the gas passes to and is adsorbed onto the second material; and
 - 10 (ii) cooling the first material so that the gas is desorbed from the second material and passes therefrom to be re-adsorbed onto the first material; whereby the second material is cooled by desorption therefrom of the gas.
- 15 2. A method as claimed in claim 1 wherein in step (i) the first material is heated by heat transfer from a relatively hotter fluid stream.
- 20 3. A method as claimed in claim 2 wherein the relatively hotter fluid stream is a waste process gas or liquid.
4. A method as claimed in any one of the preceding claims wherein, whilst the first material is being heated,25 the second material is cooled relative to the first material by heat transfer with a cooling fluid stream.
5. A method as claimed in claim 4 wherein the cooling fluid stream is a stream of ambient air.
- 30 6. A method as claimed in any one of the preceding claims wherein in step (ii) the first material is cooled relative to the second material by heat transfer to ambient or by heat transfer with a cooling fluid stream.
- 35 7. A method as claimed in claim 6 wherein the cooling fluid stream is a stream of ambient air.

8. A method as claimed in any one of the preceding claims wherein in step (ii), whilst the second material is being cooled by desorption therefrom of the gas, the
5 second material is used to cool another fluid.

9. A method as claimed in claim 8 wherein the other fluid stream is a process gas or liquid requiring cooling.

10 10. A method as claimed in claim 8 or 9 wherein, once desorption from the second material has reached completion, the second material is allowed to be slightly heated by heat transfer from the other fluid stream, just enough to restore its temperature to a level which
15 corresponds with its temperature in step (i) prior to gas adsorption thereon.

11. A method as claimed in any one of the preceding claims wherein the first gas adsorbent material has a
20 different adsorptivity to the second gas adsorbent material.

12. A method as claimed in any one of the preceding claims wherein the first gas adsorbent material is a
25 different material to the second gas adsorbent material.

13. A method as claimed in any one of the preceding claims wherein the first gas adsorbent material is a zeolite, the second gas adsorbent material is activated
30 carbon.

14. A method as claimed in any one of the preceding claims wherein the gas adsorbed onto the first and second materials is carbon dioxide.

15. A method as claimed in any one of the preceding claims wherein the gas is pressurised relative to ambient pressure.

5 16. A method as claimed in any one of the preceding claims wherein the gas is pressurised to 0.5 MPa.

17. A method as claimed in any one of the preceding claims wherein, prior to commencing step (i), the gas and
10 first and second materials are generally at ambient temperature.

18. A method of transferring heat substantially as herein described with reference to the accompanying drawings
15 and/or the Examples.

19. Heat transfer apparatus comprising a chamber having a first portion which contains a first adsorbent material and a second portion which contains a second adsorbent
20 material, the apparatus characterised in that the portions are connected so as to always allow continuous gaseous communication therebetween and are relatively thermally isolated from each other.

25 20. Apparatus as claimed in claim 19 wherein the first and second portions are joined by a section which is adapted to minimise conductive heat transfer between the first and second portions whilst allowing the continuous gaseous communication between the portions.

30 21. Apparatus as claimed in claim 20 wherein the section is a conduit having a relatively smaller width than the width of the first and second chamber portions adjacent thereto.

35 22. Apparatus as claimed in any one of claims 19 to 21 wherein one or more heat transfer elements are arranged in

each of the first and second chamber portions together with the first and second adsorbent materials.

23. Apparatus as claimed in claim 22 wherein each heat
5 transfer element comprises a metal wire mesh that enhances thermal communication between an exterior of the chamber portion and the adsorbent material therein and enhances the mass transfer rate of the gas through each of the first and second adsorbent materials.

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24. Apparatus as claimed in any one of claims 19 to 23
wherein the first and second chamber portions are each adapted to be positioned midstream of a respective flow of fluid to transfer heat between the respective fluid and
15 portion.

25. Apparatus as claimed in any one of claims 19 to 24 wherein the first and second materials are each packed into a respective portion of the chamber.

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26. Apparatus as claimed in any one of claims 19 to 24 wherein the first and second materials are as defined in claim 12 or 13.

25 27. Heat transfer apparatus substantially as herein described with reference to the accompanying drawings and/or the Examples.

28. A system for continuously transferring heat from a
30 first fluid stream and for continuously cooling a second fluid stream, the system comprising first and second apparatus each able to be brought into thermal communication with the first and second fluid streams, wherein each apparatus comprises a chamber having
35 separated first and second adsorbent materials, and each apparatus is operable in the following stages:

(1) the first material is heated by thermal communication with the first fluid stream so as to desorb a gas adsorbed onto the first material whereby the gas passes to and is adsorbed onto the second material; and

5 (2) the first material is cooled so that the gas is desorbed from the second material and passes therefrom to be re-adsorbed onto the first material, with the second material being cooled by desorption therefrom of the gas, and the second fluid stream being cooled by thermal
10 communication with the second material;
the system being characterised in that:

- whilst the first apparatus is operated under stage (1) to heat the first material of the first apparatus using the first fluid stream, the second apparatus can be
15 operated under stage (2) to cool the second fluid stream by desorption of the gas from the second material of the second apparatus; and then

- the first fluid stream can be directed to the second apparatus and operated under stage (1) of the second
20 apparatus, and the second fluid stream can be directed to the first apparatus and operated under stage (2) of the first apparatus;
to thereby provide for continuous transfer of heat from the first fluid stream and continuous cooling of the
25 second fluid stream.

29. A system as claimed in claim 28 comprising a plurality of first apparatus and a plurality of second apparatus.

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30. A system as claimed in claim 28 or 29 wherein the first and second apparatus are operated in parallel.

31. A system as claimed in any one of claims 28 to 20
35 further comprising valving for selectively switching the flow of the first and second fluid streams respectively between the first and second apparatus and the second and

first apparatus, to maintain a continuous transfer of heat from the first fluid stream and a continuous cooling of the second fluid stream.

5 32. A system as claimed in any one of claims 28 to 31 wherein each of the first and second apparatus are as defined in any one of claims 19 to 27.

10 33. A system as claimed in any one of claims 28 to 32 wherein each of the first and second apparatus are operated using a method as claimed in claim 1.

15 34. A system for continuously transferring heat from a first fluid stream and for continuously cooling a second fluid stream, the system being substantially as herein described with reference to the accompanying drawings and/or the Examples.